PURDUE UNIVERSITY

DEPARTMENT OF PHYSICS

FINAL REPORT

# RESEARCH WITH CRYSTAL COUNTERS AND SCINTILLATION COUNTERS

Contract N7onr-39420

between

PURDUE RESEARCH FOUNDATION

and

OFFICE OF NAVAL RESEARCH

June 10, 1954

# RESEARCH WITH CRYSTAL COUNTERS AND SCINTILLATION COUNTERS

Contract N7onr-39420 Terminating 30 June 1953.

The following constitutes a brief Final Report summarizing results achieved on this contract. Technical details and results are given in a Technical Report dated June 5, 1954 which is being covered for distribution to addressees on the official ONR distribution list.

During this contract period the studies of the electrical properties of organic materials begun under previous contract N7onr-39413 were continued. The materials under examination were anthracene (both in single crystal and in hexane solution), and phthalocyanine. These are members of a group of organic substances which have semiconducting properties, displaying thermal activation energies in the vicinity of 1.5 eV. and which are photoconductive. A much higher activation energy is observed optically.

It is the purpose of these investigations to gain a better understanding of the fundamental phenomena which determine the electrical behavior of these materials. Through this knowledge, it is felt that the luminescence properties so important in scintillation counting will be more clearly understood.

During the previous contract period much of the exploratory work had been completed and the instrumentation either finished or well under way. Therefore during the current period a specific program of

measurements was initiated. These are reported in considerable detail in two technical reports dated May 30, 1953 and August 1953 and in one additional technical report on the anthracene single crystal work which is in preparation. A brief summary of the important results follows:

I. Phthalocyanine

This material shows the usual straight line if the logarithm of the resistance is plotted as a function of the reciprocal temperature over range of resistance covering six orders of magnitude. The activation energy changes from sample to sample in spite of the remarkable adherence of the resistance to a simple exponential law. It is felt that such matters as orientation, previous history of the sample, and impurities may play a role in determining this activation energy. There appears to be some correlation between the single crystal thermal activation energies and the absorption bands found in thin films of the material. That this material is indeed a semi-conductor is also shown by the fact that compressed powder when in contact with a point exhibits weak but definite rectification.

II. Anthracene in hexane.

The photoconductivity exhibited by this solution was shown to be ionic in nature with both positive and negative ions participating. The mobilities of the positive and negative ions were found to be similar in magnitude. It was found conclusively that the hexane acts only as a vehicle for supporting the anthracene with respect to the primary excitation process. That is, there is no energy transfer from the

solvent to the solute.

The basic process, then must involve direct ionization of the anthracene by the exciting radiation with the subsequent formation of positive and negative ions of approximately equal size. The general features of this phenomenon appear to be only slightly connected with the luminescence and electrical conduction in single crystals.

III. Anthracene single crystals.

The photoconductive process in anthracene is electronic (i.e., not ionic) with both holes and electrons participating. The spectral dependence of the photoconductivity follows the absorption spectrum, giving an optical activation energy of about 3 eV. No saturation is observed in the relation between photocurrent and applied electric field. The photocurrent depends upon the 0.7 power of the light intensity. The thermal activation energy determined by measurement of temperature coefficient of the dark resistance is about 1.6 eV. Space charge effects have been observed the precise character of which has not been determined.

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